McMillan C•O•M•P•A•N•Y

Manual 101-M003
September 2007
Revision 3
www.mcmflow.com

MODEL 101
MODEL 102
MODEL 104
MODEL 107
MODEL S-111
MODEL S-112
MODEL S-114
FLO-SENSORS® and FLO-METERS® For Liquids

Installation Manual & Operating Instructions

READ THIS MANUAL COMPLETELY BEFORE ATTEMPTING TO CONNECT OR OPERATE YOUR FLO-SENSOR. FAILURE TO DO SO MAY RESULT IN INJURY TO YOU OR DAMAGE TO THE FLO-SENSOR.

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A. Introduction

1. Unpacking

McMillan suitably packages all sensors to prevent damage during shipping. If external damage is noted upon receipt of the package, please contact *the shipping company* immediately. McMillan Company is not liable for damage to the device once it has left the manufacturing premises.

Open the package from the top, taking care not to cut too deeply into the package. Remove all the documentation and contents. Take care to remove all the items and check them against the packing slip. The products should also be checked for any concealed shipping damage. If any shortages or damage is noted, please contact the shipping company and/or McMillan Company to resolve the problem.

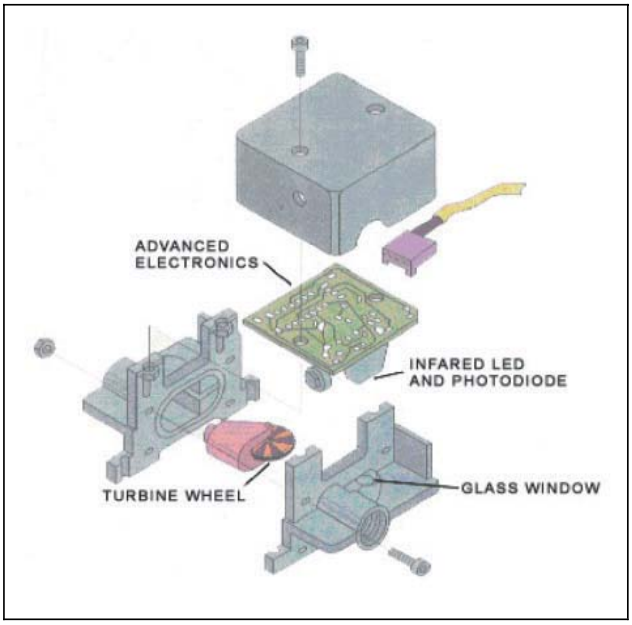
Typical Contents of Box
Sensor, Calibration Certificate & Instruction Manual
(Model 101 shown, other models similar).

CAUTION: Take care not to ***drop*** your sensor or subject it to sudden impact. Read the installation section of this manual before providing power or tubing connections to the unit. Any damage caused by improper installation or careless handling will not be repaired under warranty (see limited warranty on page 39 for more details).

2. Product Overview and Principle of Operation

McMillan Micro Turbine Wheel FLO-SENSORS® for liquids are capable of measuring flows as low as 13-100 ml/min or as high as 1.0-10.0 l/min. Highly repeatable results are achieved using a patented Pelton Turbine

Wheel flow sensor design. This proven design minimizes zero drift while maintaining fast response and linear outputs with virtually no maintenance.



McMillan's patented technology measures flow using a miniature turbine wheel similar in size to a U.S. dime (16 mm diameter, 0.75 mm thick). The micro-turbine wheel is supported on a very small sapphire shaft that is held in position by two sapphire bearings. The micro-turbine assembly is so light that it virtually floats in the liquid. This relieves force on the bearings and almost eliminates wear.

As flow passes through the FLO-SENSOR®, a precision machined nozzle directs the fluid onto the very small teeth of the micro-turbine wheel. This causes the wheel to spin at a speed proportional to the flow rate.

The micro-turbine wheel has alternating white and black sections evenly spaced on one side of the wheel. An infrared light beam is directed onto the wheel. As the wheel rotates the infrared beam is reflected off each white section. The reflected beam is detected by a phototransistor that converts the reflections into electrical pulses. As the wheel spins faster the pulse rate increases. Processing circuitry provides analog and/or pulse output that are linearly proportional to the flow rate

When the wheel stops (under zero flow conditions), no pulses are generated. Consequently, zero drift is not possible and zero adjustments are never required.

Every unit is supplied with a calibration certificate detailing the results obtained during calibration. Units are calibrated using deionized water as the reference media. Flowing liquids with different specific gravities or viscosities may effect the calibration.

3. Non-Standard Products (Z Suffixes)

Please note that the installation instructions, operating instructions, and specifications included within this manual apply to standard production models only. If your FLO-SENSOR® or FLO-METER® has a "Z" suffix (e.g. 101-*Z0123*) then your unit is non-standard. Contact the factory to check if the installation, operation, or specifications of your sensor are different than detailed in this manual.

B. Installation

CAUTION: Do not flow any gas through a liquid FLO-SENSOR® or FLO-METER®. This may damage the micro-turbine assembly and void the warranty. Do not exceed the pressure, temperature or power operating ranges detailed in the SPECIFICATIONS section of this manual. McMillan Company shall not be liable for any damage or injury caused by incorrect operation of their products.

1. General Considerations

It is recommended that a safety shut-off valve be installed upstream of (before) the sensor.

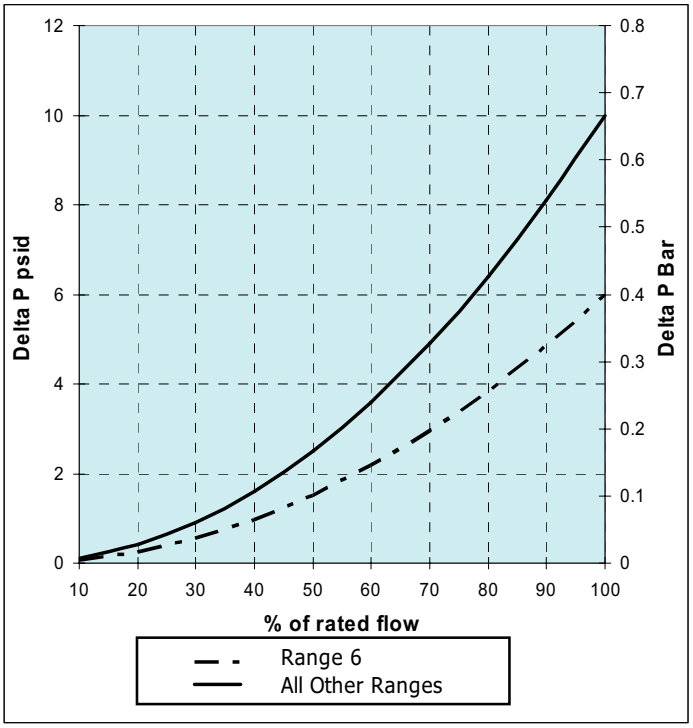
All wetted parts should be checked for compatibility with the liquid to be used. If there are any incompatibilities e.g. highly corrosive liquid, then the unit may be damaged or fail prematurely. Such damage will not be repaired under warranty.

Units should be installed in a clean, dry environment with an ambient temperature that is as stable as possible. Avoid areas with strong magnetic fields, strong air flows or excessive vibration.

If the liquid to be used may contain particles larger than 25 microns then a filter (25 microns or less) should be installed upstream of (before) the unit.

The required differential press (or pressure drop across the unit) decreases exponentially with decreases in flow rate.

Pressure Drop vs. Percentage of the Full Scale Rated Flow (may vary ±10% of indicated psid)



To calculate the pressure drop at a certain flow rate use the formula

$$\mathbf{PD = (YourFlow / MaxFlow)^2 \times PD_{max}}$$

PD = Pressure drop at YourFlow.
YourFLow = flow rate (ml/min or l/min)
MaxFlow = 100% rated flow for the sensor (in same units as YourFlow)
$\mathbf{PD_{max}}$ = Pressure drop at 100% rated flow (see chart above)

If the pressure available for the flow sensor is BELOW the pressure drop at the required flow then flow through the unit will not be possible.

For example: You have a sensor with a 50-500ml/min flow range (Range 5) and want to know the pressure drop (or minimum differential pressure required) at 300ml/min. According to the chart above, the pressure drop at 100% of flow is approx 10psi. Using the formula above:

$$PD = (300 / 500)^2 \times 10 = 3.6 \text{ psid}$$

Therefore, at 300ml/min the minimum required differential pressure for this unit is 3.6 psid. This means that if the available pressure is below 3.6psid then flow through the unit may not be possible.

Pressure drop through a system is cumulative. If the total pressure drop across all the components in a system exceeds the minimum pressure available then flow will not be possible.

For example: A system has a pressure of 30-40psi. There are several components and the sum of their pressure drops at the required flow rate is 32psid. If the system is operating at 30psi flow would not be possible as the total of the pressure drops would be greater than the pressure available. The system will only operate if the system pressure is above 32psi.

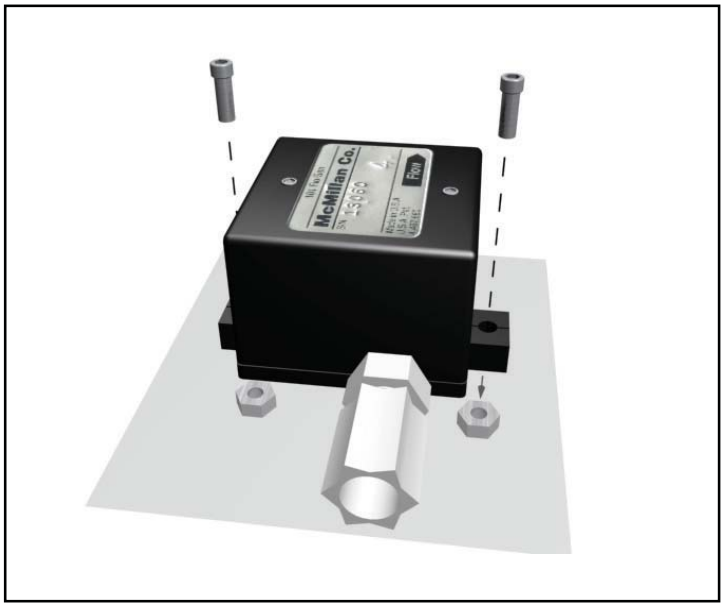
If there is any possibility that there may be bubbles or entrapped gas in the system then the outlet tubing should be elevated above the inlet port. This will enable any gas that may become entrapped in the unit to escape (see section C2 for details of how to remove entrapped air or gas).

2. Mounting the FLO-SENSOR® or FLO-METER®.

McMillan FLO-SENSORS® and FLO-METERS® have no particular installation requirements so may be mounted in any convenient position.

It is recommended that units be fixed to a suitable substrate with #4 screws using the two mounting holes provided.

Mounting The Sensor
(mounting hardware not included with sensor)

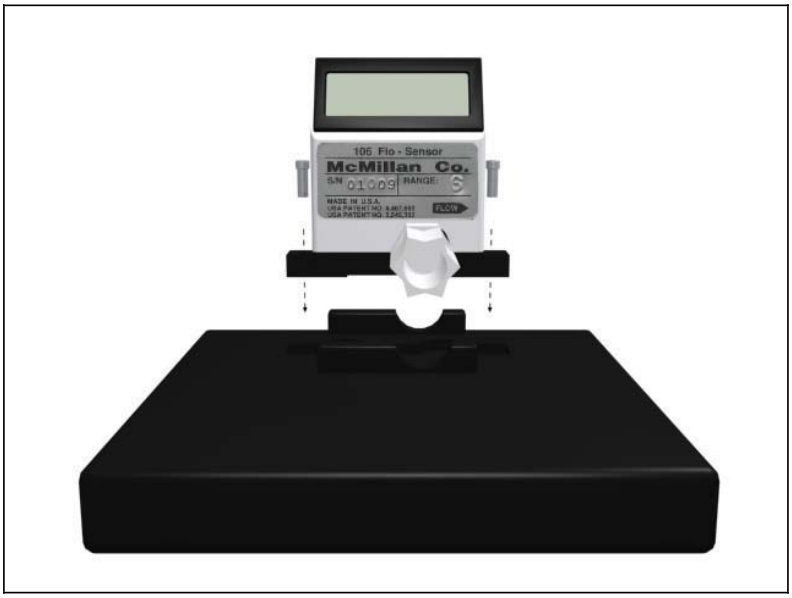


3. Mounting a FLO-METER® Using an Optional Base-plate (S-111 only).

An optional mounting base-plate (Part Number 110-00-17) is available for the Model S-111 FLO-METER®. This enables easy installation on flat, level surfaces.

The FLO-METER® and base-plate should be assembled using the screws provided.

Assembling the S-111 and Optional Base Plate



4. Tubing Connections

CAUTION: DO NOT FLOW ANY GAS THROUGH A LIQUID FLO-SENSOR® OR FLO-METER®. THIS WILL DAMAGE THE MICRO-TURBINE ASSEMBLY AND VOID THE WARRANTY.

All tubing must be clean and without crimps, burrs or scratches.

Only use the fittings factory installed on the unit. If the fittings are removed the calibration of the unit may be effected and leaking may occur. If different fittings are required please contact the McMillan Company Service Department for assistance.

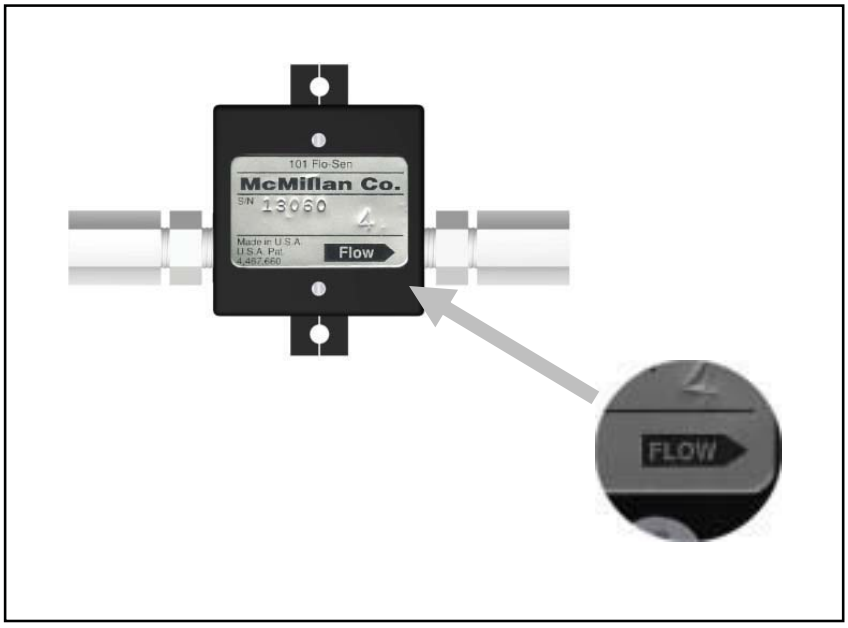
When connecting the sensor to the tubing a wrench should be used to stop the fitting rotating in the sensor body. Take care not to over tighten the fittings or leaking may occur.

Connecting and tightening the Fittings
(S Series shown, other models similar)

CAUTION: DO NOT over tighten the fittings into the FLO-SENSOR® or FLO-METER® body. Excessive force may damage the sensor body and will NOT be repaired under warranty.

The flow direction for the FLO-SENSOR® or FLO-METER® is clearly marked on the label. Do not reverse the flow direction or the unit will not function.

Close Up of Label Showing Flow Directions
(Model 101 shown, other models similar)



For the best results precautions should be taken to minimize the amount of turbulence in the flow stream. Avoid valves, fittings, curves in the tube, changes in the internal diameter or any other restrictions close to the inlet of the sensor. The tubing ID should be as large as possible and preferably not smaller than the ID of the fittings installed on the sensor.

For 0.2-2.0 L/min (Range 7) units a 10 cm straight length of tube before the sensor is recommended. For higher flow range units (0.5-5.0 L/min and 1.0-10.0 L/min), a 20 cm straight length of tubing before the sensor is recommended. If this is not possible it is recommended that straight lengths between all connections on the inlet side of the sensor are as long as possible and 90 degree fittings (with a large enough ID) are used instead of curves in the tubing.

5. Electrical Connections

CAUTION: Incorrect wiring may cause severe damage to the unit. Applying an AC voltage (115VAC or 230VAC) directly to the unit will cause damage. Read the following instructions carefully before making any connections.

a) Overview

McMillan FLO-SENSORS® provide a 0-5VDC, or 4-20mA, or 0-5VDC and pulse output (T option) proportional to the flow rate. This output may be connected to a display, data acquisition system or voltmeter / current meter.

The Model S-111, S-112 and S-114 FLO-METERS® feature an integral display that provides a local flow reading. These units also have a 0-5VDC analog output available. If required, this may be connected to another display, data acquisition system or voltmeter.

A stable D.C. power supply is required to operate the unit. The voltage and current requirements depend on the configuration of the unit. Full details may be found in the Specification section of this manual.

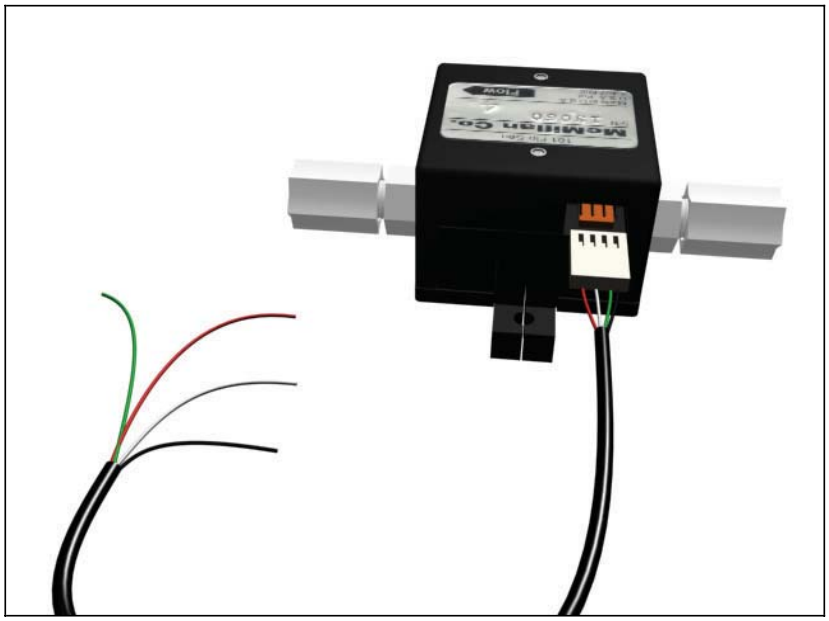
Connecting wires should be as short as possible to avoid voltage drops. Twisted 2 pair conductor cable should be used if the length of the power wires is to be longer than 1 meter.

Units are supplied with an integral 4 pin connector. Connections to the unit are made using a mating cable assembly or power adapter package as detailed in the following sections (parts 5.b to 5.h of this manual). A connector pin and wire color cross reference may also be found in Appendix I (Page 30) of this manual.

b) Connecting the Cable Assembly

The connector on the end of the cable assembly should be pushed into the mating socket on the sensor taking care to ensure that it is the correct way up.

Connecting the Cable Assembly
(Model 101 shown, other models similar)

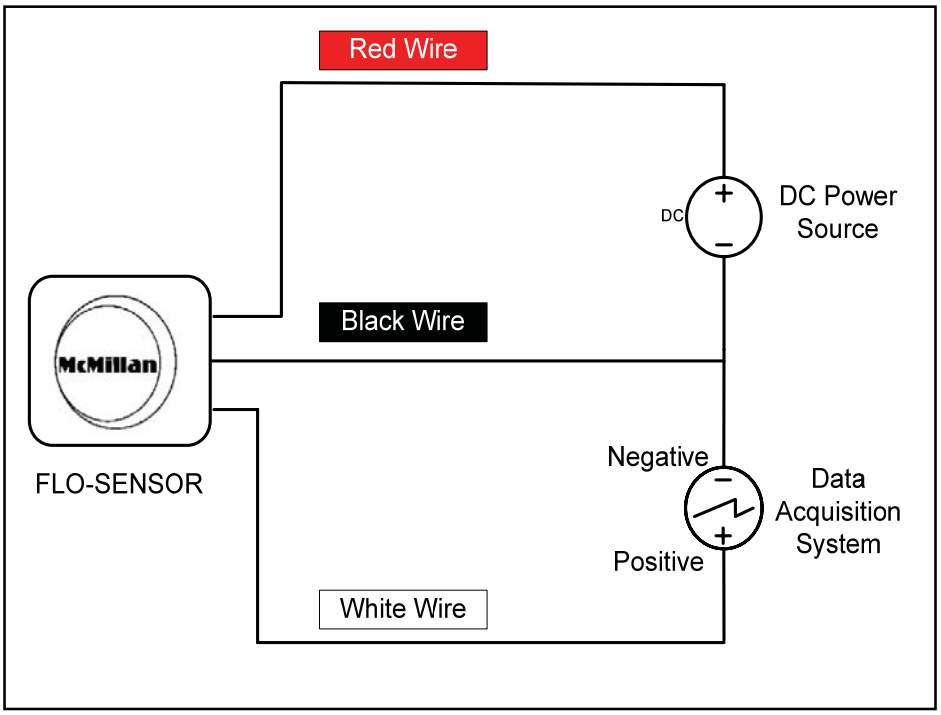


Electrical Connections are made to the cable assembly as detailed in the following sections.

c) Electrical Connections – Voltage Output Units (Standard Accuracy)

The cable assembly should be connected to the sensor as detailed in section 5(b) above. Power should not be applied to the sensor until all the connections have been made and checked. Electrical connections should be made as follows:

Wiring Schematic For Voltage Output Units.



The **RED** wire should be connected to the Positive of the power source.

The **BLACK** wire should be connected to the Negative (Ground) of the power source.

The **WHITE** wire provides the signal output and should be connected to the positive terminal of the display, data acquisition system or voltmeter with an impedance of greater than 2500Ω (Ohms).

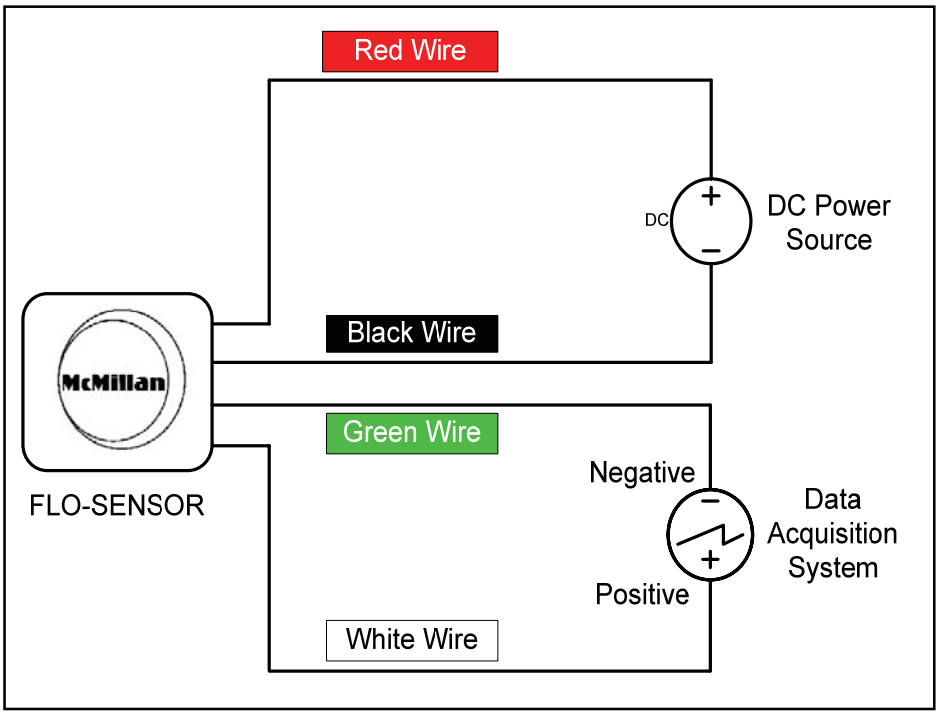
The **GREEN** wire (if present) is NOT used

CAUTION: Avoid high voltage static discharges to any of the connections. Do not short the input/output signal wires or allow them to contact the power wires at any time. DAMAGE WILL RESULT!

d) Electrical Connections – Voltage Output Units With Improved Accuracy (H Suffix Only)

The cable assembly should be connected to the sensor as detailed in section 5(b) above. Power should not be applied to the sensor until all the connections have been made and checked. Electrical connections should be made as follows:

Wiring Schematic For Voltage Output Units (H Suffix ONLY).



The **RED** wire should be connected to the Positive of the power source.

The **BLACK** wire should be connected to the Negative (Ground) of the power source.

The **WHITE** wire provides the signal output and should be connected to the positive terminal of the display, data acquisition system or voltmeter with an impedance of greater than 2500Ω (Ohms).

The **GREEN** wire should be connected to the Negative (Ground) of the display, data acquisition system or voltmeter

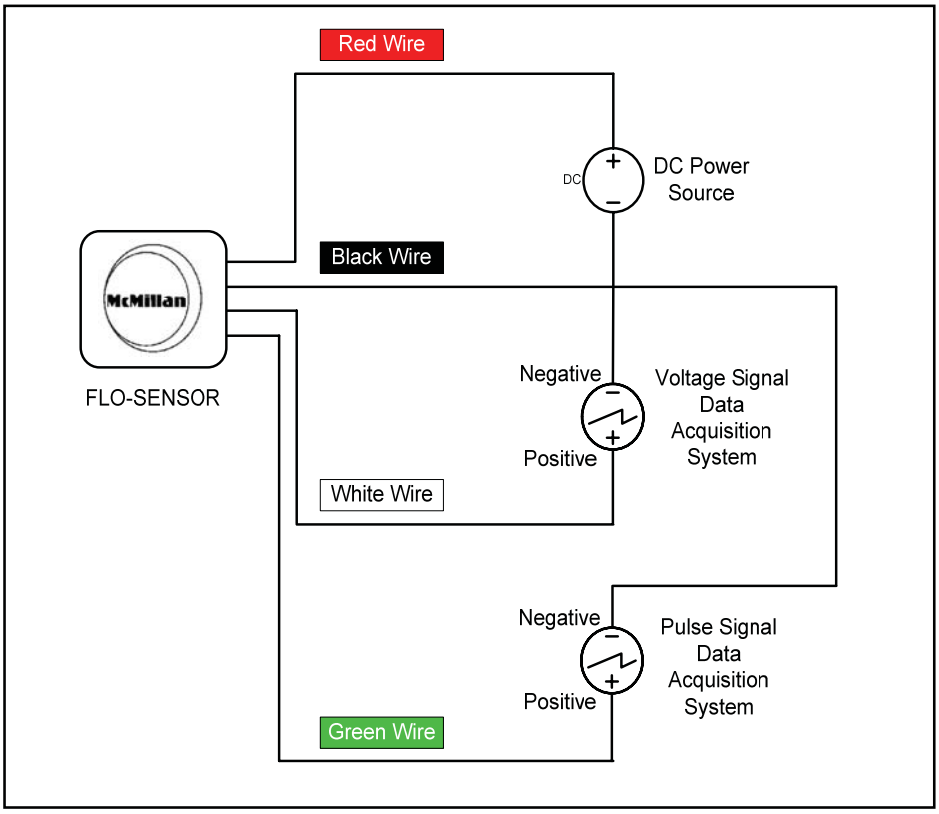
For improved accuracy units with both Voltage and Pulse outputs ("T" suffix) please see section 5(e) below.

CAUTION: Avoid high voltage static discharges to any of the connections. Do not short the input/output signal wires or allow them to contact the power wires at any time. DAMAGE WILL RESULT!

e) Electrical Connections –Units with Both Voltage and Pulse Outputs

The cable assembly should be connected to the sensor as detailed in section 5(b) above. Power should not be applied to the sensor until all the connections have been made and checked.

Wiring Schematic For Voltage and Pulse Output.



The **RED** wire should be connected to the Positive of the power source.

The **BLACK** wire should be connected to the Negative (Ground) of the power source.

The **WHITE** wire provides the signal output and should be connected to the positive terminal of the display, data acquisition system or voltmeter with an impedance of greater than 2500Ω (Ohms).

The **GREEN** wire ("T" option only) is the pulse output and should be connected to the Positive terminal of the data acquisition system with an impedance of greater than 10KΩ (Ohms).

The PULSE and VOLTAGE output may be monitored simultaneously.

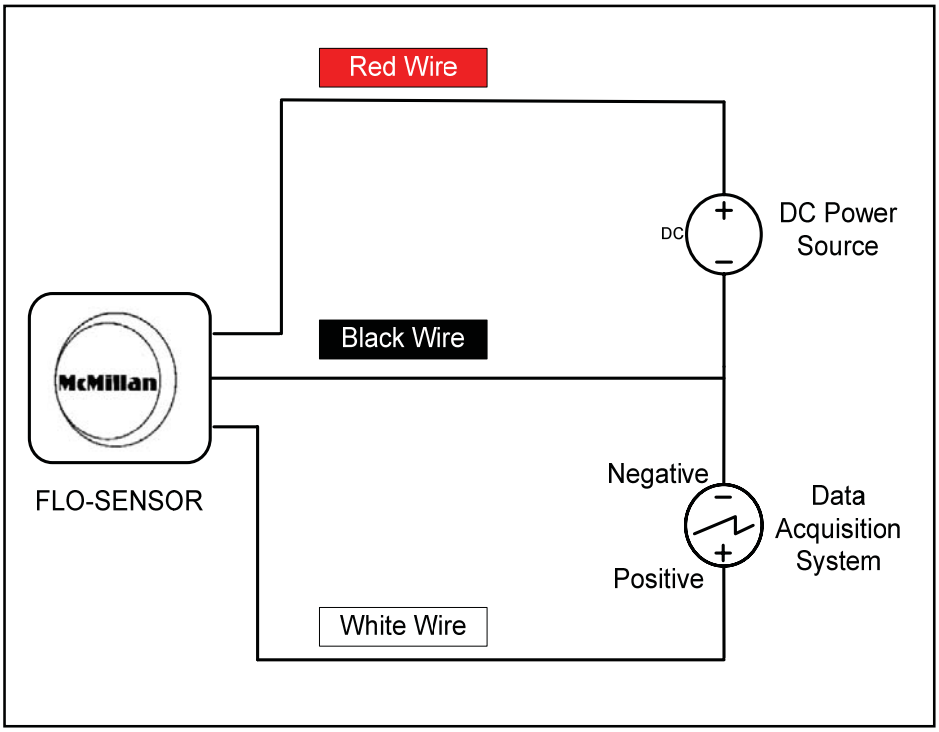
CAUTION: Avoid high voltage static discharges to any of the connections. Do not short the input/output signal wires or allow them to contact the power wires at any time. DAMAGE WILL RESULT!

f) Electrical Connections – Current Output Units (Model 107)

The Model 107 provides a 4-20mA active current output proportional to the flow rate.

The cable assembly should be connected to the sensor as detailed in section 5(b) above. Power should not be applied to the sensor until all the connections have been made and checked. Electrical connections should be made as follows:

Wiring Schematic For Model 107.



The **RED** wire should be connected to the Positive of the power source.

The **BLACK** wire should be connected to the Negative (Ground) of the power source.

The **WHITE** wire provides the signal output (active current) and should be connected to the positive terminal of the display, data acquisition system or current meter with an impedance of 0 - 500Ω (Ohms).

The **GREEN** wire is NOT used.

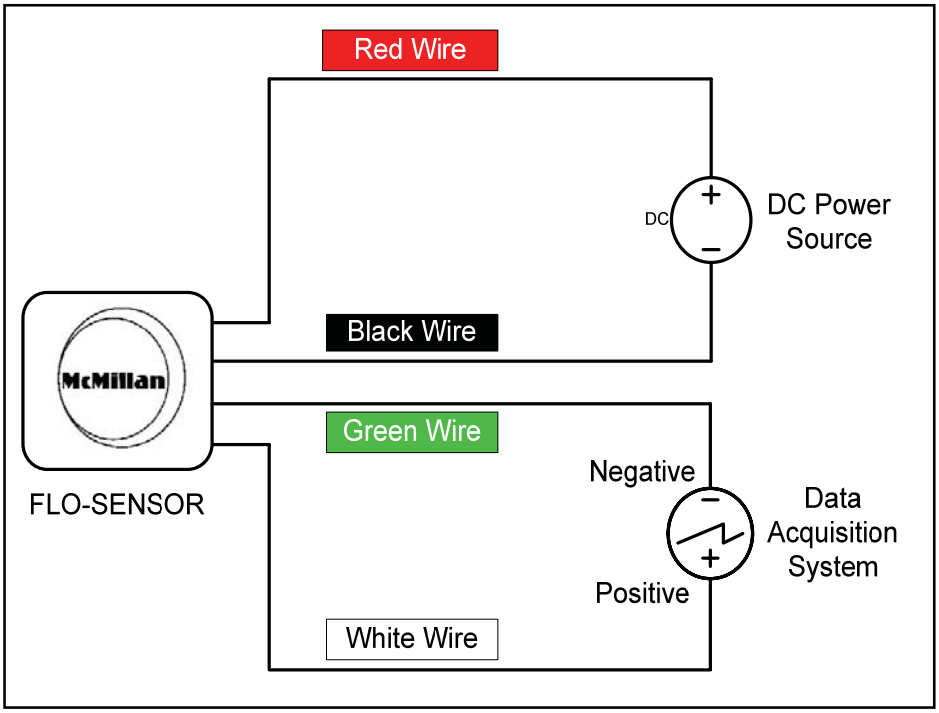
CAUTION: Avoid high voltage static discharges to any of the connections. Do not short the input/output signal wires or allow them to contact the power wires at any time. DAMAGE WILL RESULT!

g) Electrical Connections – Current Output Units (Model 107) With Improved Accuracy (H Suffix ONLY)

The Model 107 provides a 4-20mA active current output proportional to the flow rate.

The cable assembly should be connected to the sensor as detailed in section 5(b) above. Power should not be applied to the sensor until all the connections have been made and checked. Electrical connections should be made as follows:

Wiring Schematic For Model 107 With Improved Accuracy Option (H Suffix Only).



The **RED** wire should be connected to the Positive of the power source.

The **BLACK** wire should be connected to the Negative (Ground) of the power source.

The **WHITE** wire provides the signal output (active current) and should be connected to the positive terminal of the display, data acquisition system or current meter with an impedance of 0 - 500Ω (Ohms).

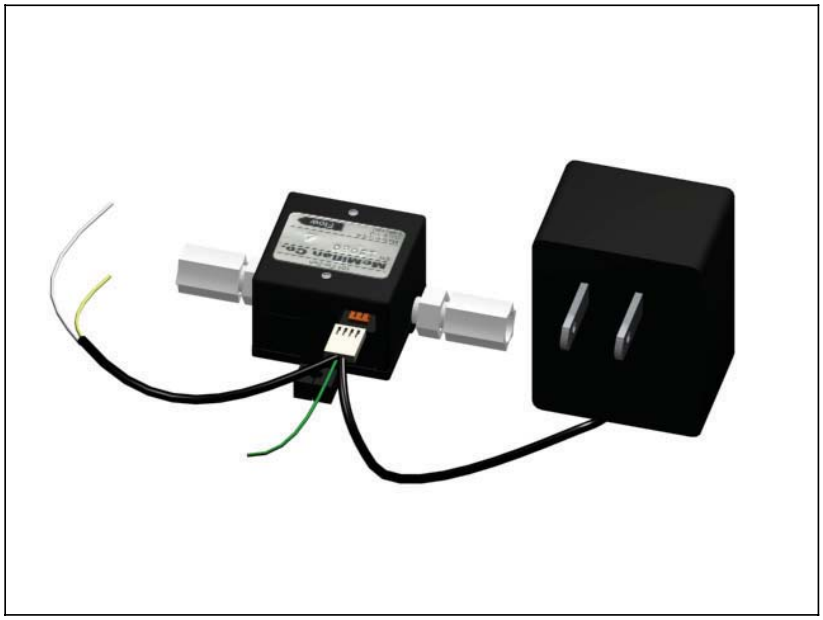
The **GREEN** wire should be connected to the Negative (Ground) of the display, data acquisition system or current meter.

CAUTION: Avoid high voltage static discharges to any of the connections. Do not short the input/output signal wires or allow them to contact the power wires at any time. DAMAGE WILL RESULT!

h) Using a 0-5VDC Output Power Adapter Package.

An optional 0-5VDC Output Power Adapter Package is available for use with the Model 101, 102, 104, S-111, S-112 and S-114. This consists of a power source (115VAC or 230VAC) and cable assembly with pig-tail (soldered wire) ends for the signal output. This should be assembled as shown in the following diagram.

Connecting the Power Adapter to the Flow Sensor
(Model 101 shown, other models similar)



Electrical connections to the cable assembly should be made as follows:

YELLOW WIRE: This provides the 0-5VDC signal output and should be connected to the positive terminal of the display, data acquisition system or voltmeter with an impedance of greater than 2500Ω (Ohms).

GREEN WIRE: For Pulse output units ("T" suffix only) the green wire provides the pulse output and should be connected to the positive terminal of the data acquisition system with an impedance of greater than 10KΩ (Ohms).

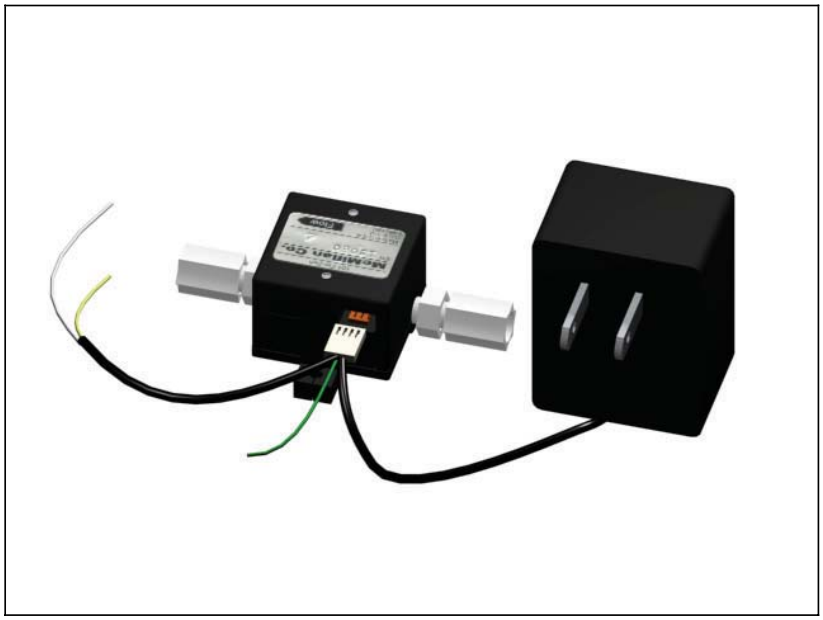
WHITE WIRE: This is the signal negative and should be connected to the negative (ground) terminal of the voltmeter, display or data acquisition system.

CAUTION: Avoid high voltage static discharges to any of the connections. Do not short the output signal wires or allow them to contact the power wires at any time. DAMAGE WILL RESULT!

i) Using a 4-20mA Output Power Adapter Package (Model 107).

An optional 4-20mA Output Power Adapter Package is available for use with the Model 107. This consists of a power source (115VAC or 230VAC) and cable assembly with pig-tail (soldered wire) ends for the signal output. This should be assembled as follows:

Connecting the Power Adapter to the Flow Sensor
(Model 101 shown, other models similar)



The 4-20mA output may be connected to a display, data acquisition system or current meter. Wiring connections should be made as follows:

The **YELLOW** wire of the cable assembly provides the 4-20mA (active current) signal output and should be connected to the positive terminal of a display, data acquisition system or current meter with an impedance of 0 - 500Ω (Ohms).

The **GREEN** wire of the cable assembly is not used

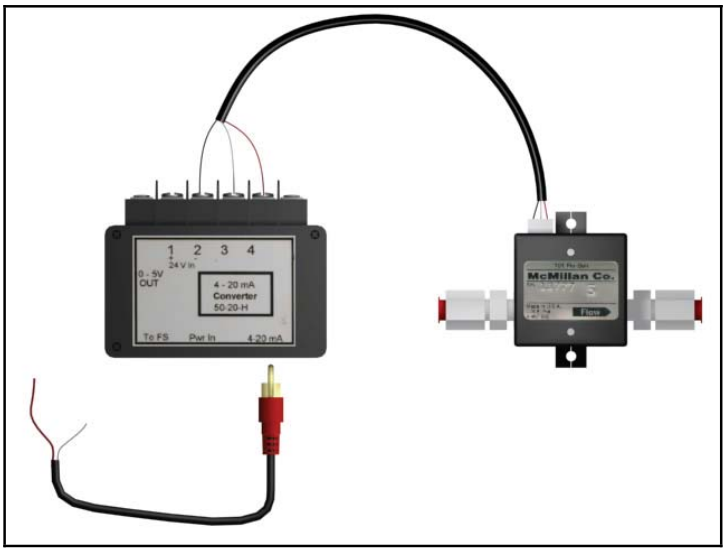
The **WHITE** wire of the cable assembly is the signal negative and should be connected to the negative (ground) terminal of the current meter, display or data acquisition system.

CAUTION: Avoid high voltage static discharges to any of the connections. Do not short the output signal wires or allow them to contact the power wires at any time. DAMAGE WILL RESULT!

j) Using a 4-20mA Output Signal Converter Package (D-24 VDC).

An optional 4-20mA Output Signal Converter Package is available for use with the Model 101, 102, 104, S-111, S-112 and S-114. This consists of a signal converter, a cable assembly to connect the converter to the sensor and a cable assembly to connect to the 4-20mA (active current) output signal. The signal converter requires 24VDC power to operate. This package should be assembled as shown in the following diagram.

Assembling the D-24VDC 4-20mA Signal Converter Package (Model 101 shown, other models similar)



i) Electrical connections to the **FLOW SENSOR** cable assembly

The **RED** wire should be connected to **PIN 4** of the signal converter unit.

The **BLACK** wire should be connected to **PIN 2** of the signal converter unit.

The **WHITE** wire should be connected to **PIN 3** of the signal converter unit.

The **GREEN** wire (if present) is NOT used

ii) Connecting a power supply.

A stable low noise 24 VDC power supply should be connected to the signal converter as follows:

PIN 1 of the signal converter unit should be connected to the Positive of the power source.

PIN 2 of the signal converter unit should be connected to the Negative (Ground) of the power source.

iii) Electrical connections to the **4-20mA FLOW SIGNAL OUTPUT** cable assembly:

The **CENTER** wire of the cable assembly provides the 4-20mA (active current) signal output and should be connected to the positive terminal of the display, data acquisition system or current meter with an impedance of 0 - 500Ω (Ohms).

The **SHIELD** wire of the cable assembly is the signal negative and should be connected to the negative (ground) terminal of the current meter, display or data acquisition system.

CAUTION: Avoid high voltage static discharges to any of the connections. Do not short the output signal wires or allow them to contact the power wires at any time. DAMAGE WILL RESULT!

C. Operation

CAUTION: USE WITH LIQUIDS ONLY. FLOWING GAS OR AIR THROUGH YOUR FLO-SENSOR® OR FLO-METER® WILL DAMAGE THE MICRO-TURBINE ASSEMBLY. THIS TYPE OF DAMAGE WILL NOT BE REPAIRED UNDER WARRANTY.

1. Start Up

Before applying power to the unit check all tubing and electrical connections. Once correct installation is verified switch on the power.

2. Entrapped Air or Gas

There may be a lot of air or gas trapped in your FLO-SENSOR® or FLO-METER® after installation. This will usually escape the unit when flow (within the range of the unit) is first started.

CAUTION: The system should be primed with liquid and flow started gradually. This will prevent trapped air or gas from being forced through the sensor at a high velocity that may damage the sensor.

If gas remains entrapped in the unit it may be necessary to elevate the outlet tubing above the inlet of the FLO-METER® or FLO-SENSOR®. This should enable the trapped gas to escape the unit. The FLO-SENSOR® or FLO-METER® may be returned to it's original position once all the gas has escaped.

If elevating the outlet tubing does not work, block or pinch the outlet tube whilst there is flow in the system. After approximately 5 seconds, release the restriction to allow normal flow. Doing this will build up pressure in the flow path that when released will help remove the entrapped gas. Repeat this until the entrapped gas is removed form the unit.

3. Flow Readings

McMillan FLO-SENSORS® provide a 0-5VDC, or 4-20mA, or 0-5VDC and pulse output (T option) proportional to the flow rate. The type of output signal is detailed in the part number reference and on the calibration certificate.

The Model S-111, S-112 and S-114 FLO-METERS® feature an integral display that provides a local flow reading and a 0-5VDC analog output.

Each FLO-SENSOR® or FLO-METER® is factory calibrated for a specific flow range. The flow range is shown on the unit's label and calibration certificate. Units are calibrated using deionized water as the reference media.

a) 0-5VDC Analog Outputs

By monitoring the voltage output signal it is possible to determine the flow rate of the liquid. Units are configured so that an output signal of 5.0VDC is provided when the maximum flow (i.e. Full Scale flow) is passing through the unit. The output signal is linear and scaleable enabling calculation of flow rates within the sensor's range. For example:

> For a flow range of 50-500ml/min (Range 5) :
>
> At 500ml/min the output signal would be 5VDC
>
> If the output signal were 3.5VDC then the flow rate would be:
>
> 500 ÷ 5 × 3.5 = 350ml/min

If the maximum flow rate is exceeded non-linear and inaccurate readings will result.

b) Pulse Outputs

By monitoring the Pulse output frequency it is possible to determine the flow rate of the liquid. The pulse frequency for maximum flow through the unit (i.e. full scale flow) is detailed on the calibration certificate. This differs from unit to unit. This output is approximately linear and scaleable within the sensor's range. For example:

> For a flow range of 1.0-10.0l/min (Range 9) :
>
> The calibration certificate gives the following:
>
> At 10.0l/min the pulse output signal is 312Hz
> At 5.0l/min the pulse output signal is 150Hz
> At 2.0l/min the pulse output signal is 58Hz
>
> If the output signal were 120Hz then the flow rate would be:
>
> 5.0 ÷ 150 × 120 = 4.0 l/min (using the closest calibration point)

c) 4-20mA Outputs

By monitoring the current output signal it is possible to determine the flow rate of the liquid. Units are configured so that an output signal of 20mA is provided when the maximum flow (i.e. Full Scale flow) is passing through the unit. The output signal is 4mA when there is zero flow through the unit. The output signal is linear and scaleable enabling calculation of flow rates within the sensor's range. For example:

> For a flow range of 20-200ml/min (Range 4) :
>
> At 200ml/min the output signal would be 20mA
>
> If the output signal were 9mA then the flow rate would be:
>
> 200 ÷ (20-4) × 9 = 112.5ml/min

d) Units With an Integral Display

The Model S-111, S-112 and S-114 feature an integral 3 ˝ digit LCD display. This is configured to read in ml/min for flow ranges 2-5 and in l/min for flow ranges 6-9. The display will only operate if power is applied to the unit.

Flow readings may be taken directly from the display or by monitoring the 0-5VDC analog output provided by using a cable assembly or power adapter package (see above).

LCD Flow Display
(Model S-114 shown, other S Series models similar)

4. Operating at Flow Rates Outside the Calibrated Flow Range

CAUTION: If the flow through the unit exceeds 120% of the maximum rated (full scale) flow the unit may be damaged. This type of damage will not be repaired under warranty.

Flow measurement is only accurate within the calibrated flow range for the unit. This is detailed on the calibration certificate. The unit will still operate, to some degree, outside this flow range.

Results obtained when operating outside the specified range of the unit are not accurate but may be considered repeatable.

a) Flows Above the Maximum Rated Flow.

If the flow rate is above the maximum rated (or full scale) flow, the unit will still operate and provide an output signal proportional to the flow rate.

Flows must not exceed 120% of the maximum rated flow or the unit may be damaged.

b) Flows Below the Minimum Rated Flow.

Signal outputs may be obtained at flow rates below the minimum specified for your unit. The amount of flow that may be measured below the minimum specified varies from unit to unit.

5. Zero Adjustments

It is impossible for there to be any zero drift so zero adjustments are never required.

6. Recalibration

The calibration of the FLO-SENSOR® or FLO-METER® may be easily verified using empirical methods.

It should be noted that the use of empirical methods outside a certified calibration laboratory is subject to inaccuracy and error. These methods should only be used to gain an indication of a sensor's performance. Please contact the McMillan Service Department if accurate, certified recalibration is required.

A typical empirical calibration check may be carried out as follows:

Carefully adjust the flow rate so that the maximum output signal is obtained. With the flow rate constant, liquid flowing through the unit should be gathered in a container over a timed interval. The total volume flowed over the timed period should then be measured using a measuring cylinder. The actual flow rate (in the same units as the flow sensor calibration certificate) may then be calculated. The actual maximum flow rate should then be compared to the specified maximum flow rate to determine the error in calibration. For example:

> For a flow range of 20-200ml/min (Range 4) with a 0-5VDC output:
>
> With a constant flow and constant 5VDC output the actual volume measured over 30 seconds was 102ml.
>
> Therefore the actual flow rate is:
>
> (102 / 30) x 60 = 204ml/min
>
> The error is therefore 204 – 200 = 4ml/min or 2%

A second empirical check should be made at a flow rate below the maximum for the unit e.g. at 50% of full scale. The calculated percentage error at this flow should then be compared to the error at maximum flow. If there is a big difference in the percentage errors then the flow signal is no longer linear and the unit may be damaged (consult the McMillan Service Department).

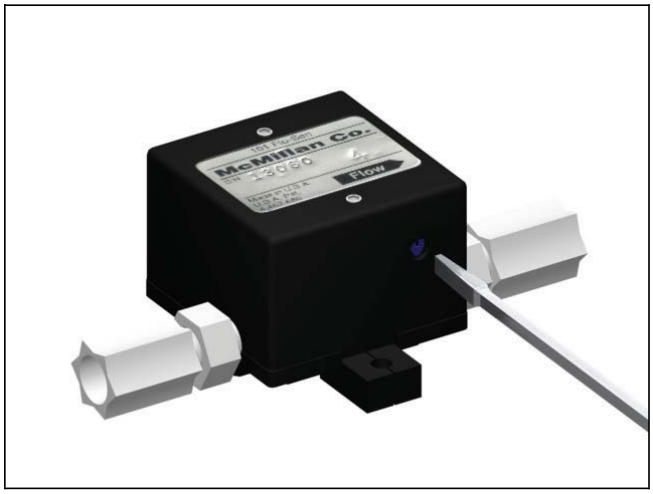
Once it has been determined that the linearity is still acceptable and the error in flow reading at maximum flow has been calculated, there are 3 options:

i.) Minor adjustments to actual calibration of the FLO-SENSOR® or FLO-METER® may be made by turning the gain potentiometer on the side of the unit. For example:

> For a unit with a flow range of 13-100ml/min (Range 3) and a 0-5VDC output:
>
> With a constant flow and constant 5VDC output the actual volume measured over 60 seconds was 103ml.
>
> The correct voltage output for a flow of 103 ml/min is:
>
> (5/100) x 103 = 5.15 V
>
> With the flow at a constant 103 ml/min the gain potentiometer should be carefully adjusted so that a voltage output reading of 5.15 V is obtained.

If the unit cannot be suitably adjusted please contact the McMillan Service Department. Pulse outputs are not adjustable.

Adjusting the Gain Potentiometer Using a Flat Head Screwdriver (Model 101 shown, other models similar)



ii.) Adjust the scaling endpoints in the display or data acquisition system. For example:

For a flow range of 50-500ml/min (Range 5) with a 0-5VDC output:

With a constant flow and constant 5VDC output the actual volume measured
over 60 seconds was 405ml.

Therefore the actual flow rate is:

(405 / 60) x 60 = 405ml/min

The display or data acquisition system may now to configured as follows:

0 VDC = Zero flow
5VDC = 405ml/min

iii.) Apply the error factor to each flow reading taken. For example:

For a flow range of 0.2-2.0l/min (Range 7) connected to a display:

With a constant flow rate of 2.0 l/min on the display, the actual volume measured over 20 seconds was 0.7l

Therefore the actual flow rate is:

(0.7 / 20) x 60 = 2.1 l/min

The error is therefore 2.1 – 2.0 = 0.1 l/min or 5%

If the display shows an uncorrected flow rate of 1.4 l/min then :

Corrected flow rate = Uncorrected flow rate + error

Corrected flow rate = 1.4 + 5% = 1.47 l/min

7. Calibrating FLO-SENSORS® or FLO-METERS® for Different Liquids

McMillan FLO-SENSORS® or FLO-METERS® will operate with most translucent liquids subject to compatibility of the wetted parts. Best results are obtained with low viscosity (less than 10 centistokes) liquids. For information regarding higher viscosity liquids, contact the McMillan Service Department.

Units are calibrated with deionized water as the reference media. Using other liquids will effect the calibration. The amount of calibration error will depend on the characteristics of the liquid being flowed.

The error in flow reading (or calibration) should be calculated and utilized as detailed in section 6 above.

D. Maintenance and Product Care

1. General

CAUTION: Do not disassemble your FLO-METER® or FLO-SENSOR® for any reason. If the unit appears to be malfunctioning please contact the McMillan Service Department.

McMillan FLO-SENSORS® and FLO-METERS® require no periodic maintenance if used within the recommended specifications.

The next recommended recalibration date is stated on the calibration certificate supplied with the unit. Please contact the McMillan Service Department for further information.

Inlet filters should be periodically checked and cleaned / replaced as necessary.

Regularly check all electrical and process connections for damage or deterioration.

If the sensor is to be stored, keep both the inlet and outlet ports sealed.

Do not store a FLO-METER® or FLO-SENSOR® with any chemical other than water (or air) inside it over an extended period of time. Prolonged exposure to chemicals other than water may lead to precipitation or corrosion.

2. Cleaning and Flushing

If there is a build up of deposits or residues from the measured chemicals it may be necessary to clean *or flush* the unit. This should be done by flowing clean, particle free water through the unit at a flow rate, pressure and temperature within the specifications of the unit. If necessary, flow may be reversed to assist flushing.

Under no circumstances should gas or air be flowed through the unit. This will cause severe damage.

3. Returning Units for Repair or Recalibration

To return a unit for repair or recalibration please contact the McMillan Service Department or follow the procedure detailed on the McMillan web site. A Return to Manufacturer Authorization (RMA) number will then be issued to enable the unit to be returned. Please note that no returns will be accepted unless the RMA number is clearly indicated on the outside of all packages.

Once the unit has been received it will be evaluated and the cost of any repairs / recalibration determined. Once agreement has been received to pay for all the necessary work the unit will be processed and returned. No charges will be made for Warranty Repairs (see section J).

The McMillan Service Department may be contacted as follows:

Mailing address: McMillan Company
P.O. Box 1340
Georgetown, TX 78627
U.S.A.

Phone: U.S.A. (512) 863-0231
Fax: U.S.A. (512) 863-0671

Email: tech@mcmflow.com

Website: www.mcmflow.com

E. Part Number Information

DESCRIPTION	CODE
Model 101 FLO-SENSOR®	101
Model 102 FLO-SENSOR®	102
Model 104 FLO-SENSOR®	104
Model 107 FLO-SENSOR®	107
Model S-111 FLO-METER®	S-111
Model S-112 FLO-METER®	S-112
Model S-114 FLO-METER®	S-114
Flow Range (ml/min of water)	
13-100 ml/min	3
20-200 ml/min	4
50-500 ml/min	5
100-1000 ml/min	6
200-2000 ml/min	7
500-5000 ml/min	8
1000-10000 ml/min	9
Power / Output Signal	
11.5-15.0 VDC / 0-5 VDC Output	D (except Model 107)
18.0-25.0 VDC / 0-5 VDC Output	E
11.5-15.0 VDC / 0-5 VDC + Pulse Output	T
18.0-25.0 VDC /* 4-20mA Output	Standard (Model 107 only)
Seal Codes	
Viton®	Standard
EPDM	Q
Bearing Support Codes	
Stainless Steel	Standard
Kel-F	K
Impact Resistant Stainless Steel	N
Fittings	
1/8" acetal compression tube	A2
1/4" acetal compression tube	A4
3/8" acetal compression tube	A6
1/8" Kynar PVDF compression tube	K2
1/4" Kynar PVDF compression tube	K4
3/8" Kynar PVDF compression tube	K6
1/8" brass compression	B2
1/4" brass compression	B4
3/8" brass compression	B6
1/8" stainless steel compression	S2
1/4" stainless steel compression	S4
3/8" stainless steel compression	S6
6 mm stainless steel compression	M6
10 mm stainless steel compression	M10
1/4" Nylon barb	AB
1/4" stainless steel barb	SB
Options	
Improved Accuracy of ±0.5% F.S. Including NIST Calibration Certificate	H
NIST-Traceable Calibration Certificate	NIST
Epoxy Potted Electronics	Y

Note: Please refer to the product datasheet for the availability of specific options.

F. Accessories

DESCRIPTION	CODE
Cables and Power Adapters (Ordered Separately, Recommended For Operation)	
4-pin Mating Cable with Pigtail Leads, 36" (92 cm) length 3 wire, 12/24VDC Power Required	100-17
4-pin Mating Cable with Pigtail Leads, 36" (92 cm) length 4 wire, 12/24 DC Power Required	100-17T
110VAC Power Adapter Package, 0-5VDC Output *For 12VDC Models with 0-5VDC and Pulse outputs*	110-00-08T
230VAC Power Adapter Package, 0-5VDC Output *For 12VDC Models with 0-5VDC and Pulse outputs*	110-00-18T
110VAC Power Adapter Package, 0-5VDC Output *For 12VDC Models with 0-5VDC output*	S-PS-08
230VAC Power Adapter Package, 0-5VDC Output *For 12VDC Models with 0-5VDC output*	S-PS-18
110VAC Power Adapter Package, 4-20mA Output (Model 107 only) *For 12VDC Models with 4-20mA output*	104-10-08
230VAC Power Adapter Package, 4-20mA Output (Model 107 only) *For 12VDC Models with 4-20mA output*	104-10-18
Displays (Ordered Separately, More Information Available)	
210R Rate Display, 3" digit, 5-30 VDC Power	210R
250 Multi-Function Display, 115 VAC Power	250
250E Multi-Function Display, 230 VAC Power	250E
Analog Output Card for Model 250/250E Display	250-10
Alarm Output Card for Model 250/250E Display	250-11
Miscellaneous (Ordered Separately)	
Base plate for S-111 *Allows bench mounting*	110-00-17

G. Specifications

	Model 101	Model 102	Model 104	Model 107
Analog Signal Accuracy (including linearity)	±1.0% Full Scale[1] ±0.5% Full Scale for "H" option[1]			
Repeatability	±0.2% Full Scale[1] ±0.5% Full Scale for "N" option[1]			
Pressure Rating	100 psig (6.8 bar)	500 psig (34.5 bar)		
Temperature Rating	Operating Range: 5 to 55°C Storage Range: 0 to 70°C			
Temperature Sensitivity	±0.2% F.S.[1] or less per °C			
Wetted Materials	Ryton® 316 Stainless[2] Epoxy Glass Sapphire	Brass Ryton® 316 Stainless[2] Epoxy Glass Sapphire	316 Stainless Ryton® Epoxy Glass Sapphire Kel – F ("K" option Only)	
O-Ring Material	Standard - Viton® EPDM for "Q" Option			
Fitting Material (Standard)	Acetal	Brass	Stainless Steel	
Fitting Material Optional	Kynar PVDF Brass Stainless Steel	Acetal Kynar PVDF Stainless Steel	Acetal Kynar PVDF Brass	
Recommended Filtration	25 microns or less			
Compatible Liquids	Low viscosity (ideally <10cS) Translucent or transparent Minimum amount of entrapped air or gas			
0-5VDC Output Signal	Standard Minimum 2.5 KΩ load			N/A
Pulse Output Signal	"T" Option 7.5VDC peak buffered square wave Typically 0-400Hz ±3.0% Full Scale accuracy			N/A
4-20mA Output Signal	N/A			Non Isolated Current loop should be <500Ω
Typical Power Consumption	Standard: 12 VDC @ 35 mA (11.5-15 VDC) "E" Suffix: 24 VDC @ 35 mA (18-25 VDC)			24VDC @ 65mA
Response Time	Typically <1 second for 63% of final value			
Reliability	100,000 hours MTBF			
Certifications	CE Approved 89/336/EEC (EN 55011 & EN 50082-1) 73/23/EEC Low Voltage Directive			
Ratings	IP10 (NEMA 1) "Y" Option IP67 (NEMA 6)			
Warranty	1 year limited			

1. Specifications from 10-100% of rated flow. Linearity is best fit straight line. All calibrations performed with deionized water unless otherwise stated on calibration certificate

2. Stainless Steel replaced by KEL-F with "K" option.

	Model S-111	Model S-112	Model S-114
Display	3.5 Digit Non Backlit LCD, 0.39" (10mm) high digits		
Accuracy (including linearity)	±1.0% Full Scale[1] ±0.5% Full Scale for "H" option[1]		
Repeatability	±0.2% Full Scale[1]		
Pressure Rating	100 psig (6.8 bar)	500 psig (34.5 bar)	
Temperature Rating	Operating Range: 5 to 55°C Storage Range: 0 to 70°C		
Temperature Sensitivity	±0.2% F.S.[1] or less per °C		
Wetted Materials	Ryton® 316 Stainless[2] Epoxy Glass Sapphire	Brass Ryton® 316 Stainless[2] Epoxy Glass Sapphire	316 Stainless* Ryton® Epoxy Glass Sapphire Kel F ("K" option only)
O-Ring Material	Standard - Viton® EPDM for "Q" Option		
Fitting Material (Standard)	Acetal	Brass	Stainless Steel
Optional Fitting Materials	Acetal, Kynar PVDF, brass, or stainless steel		
Recommended Filtration	25 microns or less		
Compatible Liquids	Low viscosity (ideally <10cS) Translucent or transparent Minimum amount of entrapped air or gas		
0-5VDC Output Signal	Standard Minimum 2.5 KΩ load		
Typical Power Consumption	Standard: 12 VDC @ 35 mA (11.5-15 VDC) "E" Suffix: 24 VDC @ 35 mA (18-25 VDC)		
Response Time	Typically <1 second for 97% of final value		
Reliability	100,000 hours MTBF		
Certifications	CE Approved 89/336/EEC (EN 55011 & EN 50082-1) 73/23/EEC Low Voltage Directive		
Ratings	IP10 (NEMA 1)		
Warranty	1 year limited		

1. Specifications from 10-100% of rated flow. Linearity is best fit straight line. All calibrations performed with deionized water unless otherwise stated on calibration certificate

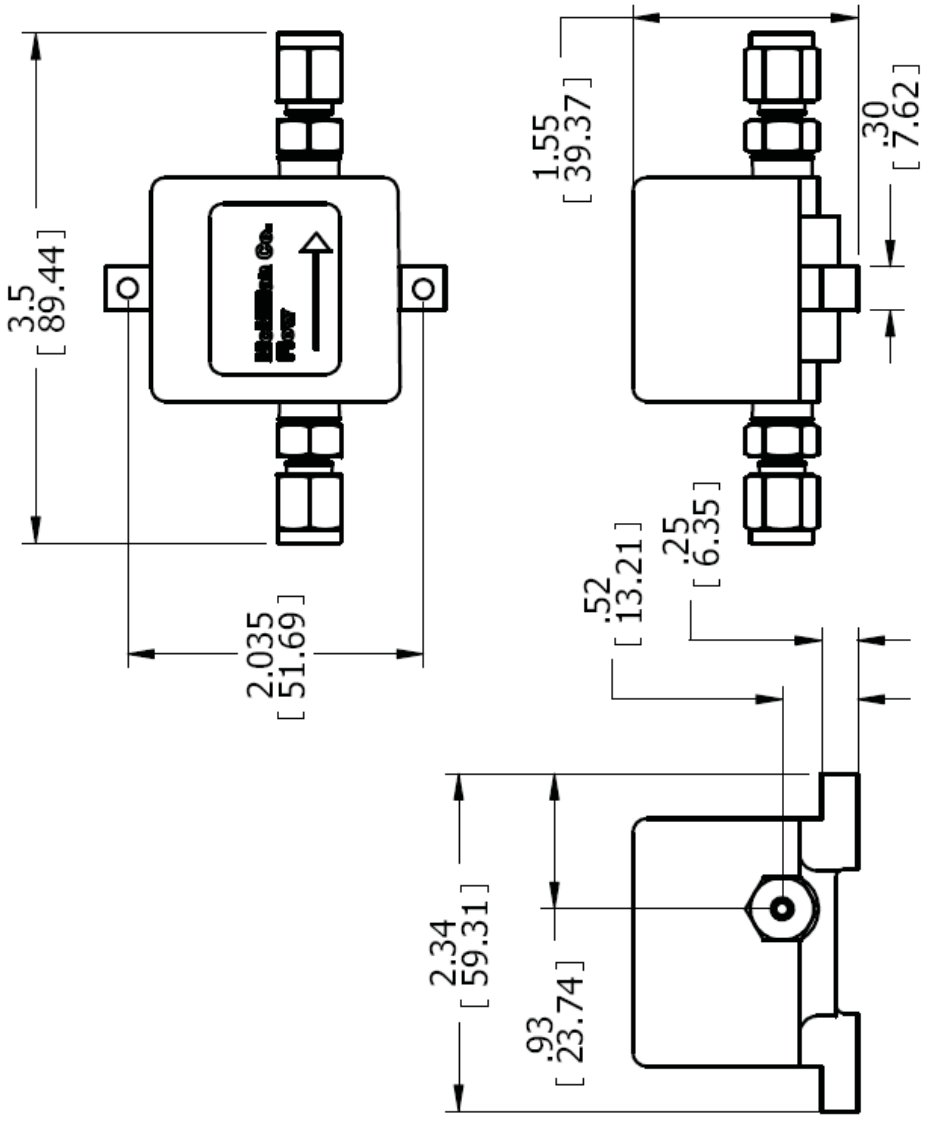
2. Stainless Steel replaced by KEL-F with "K" option.

.

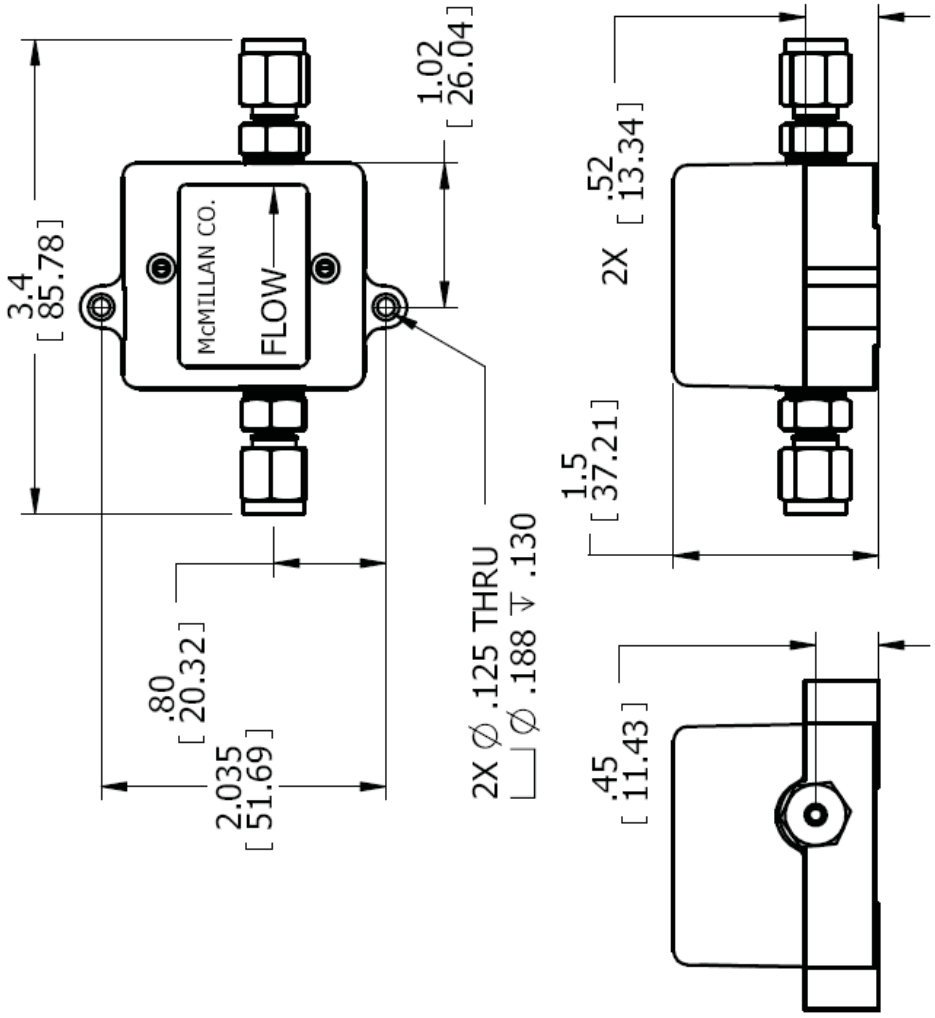
H. Dimensions

ALL DIMENSIONS IN INCHES (MILLIMETERS IN BRACKETS)

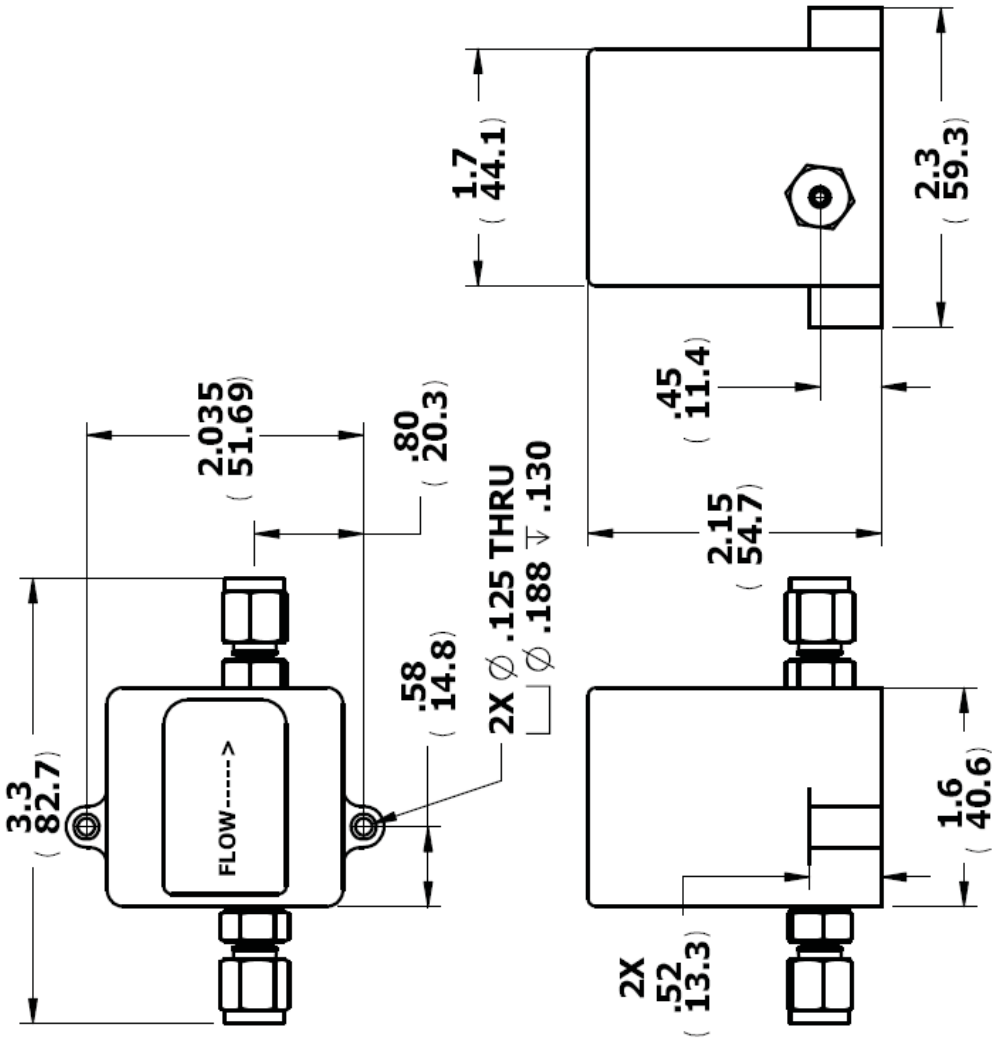
Model 101 - Flow Ranges 3-9,
"A4" Fittings Shown



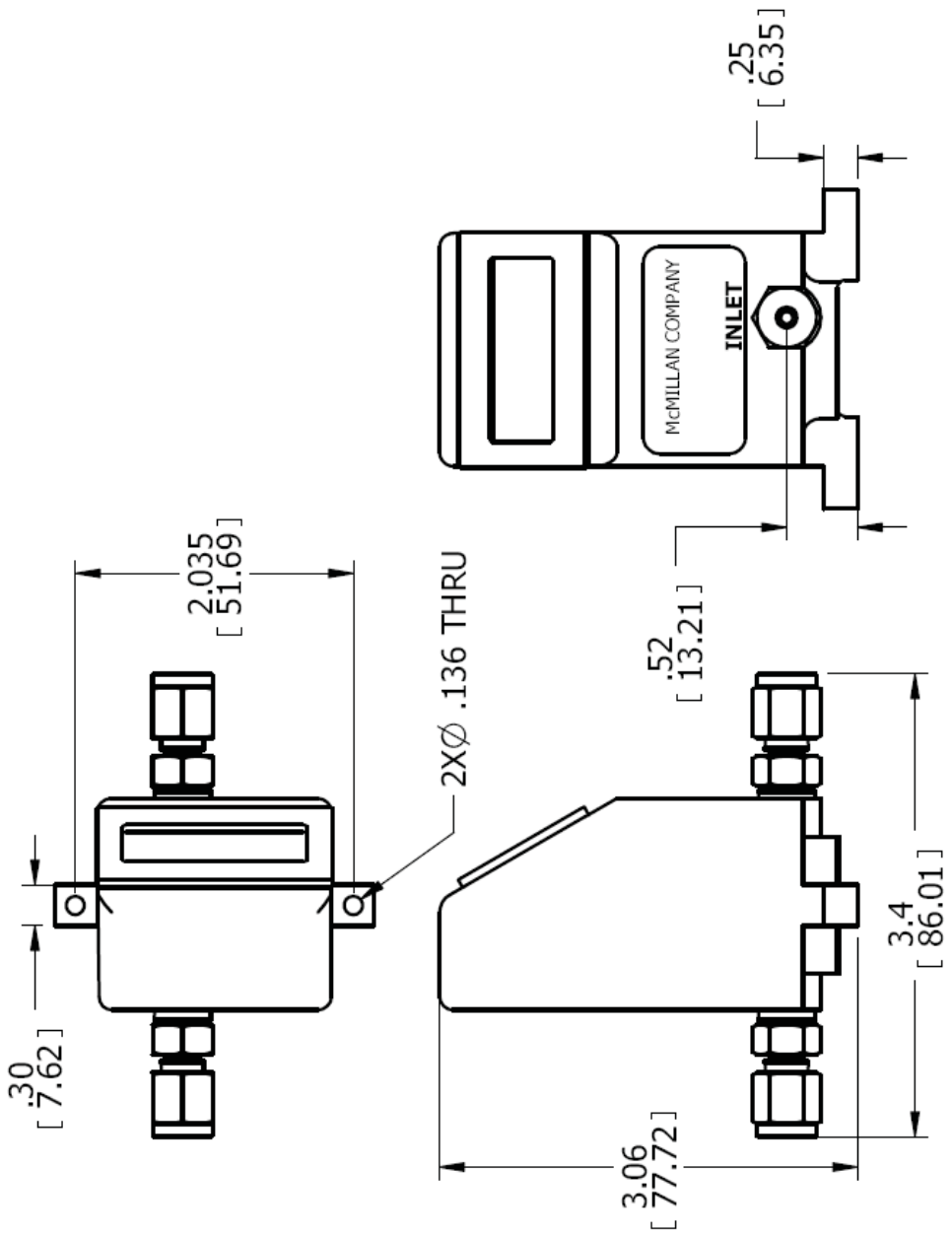
Model 102 & 104 - Flow Ranges 3-9,
"B4/S4" Fittings Shown



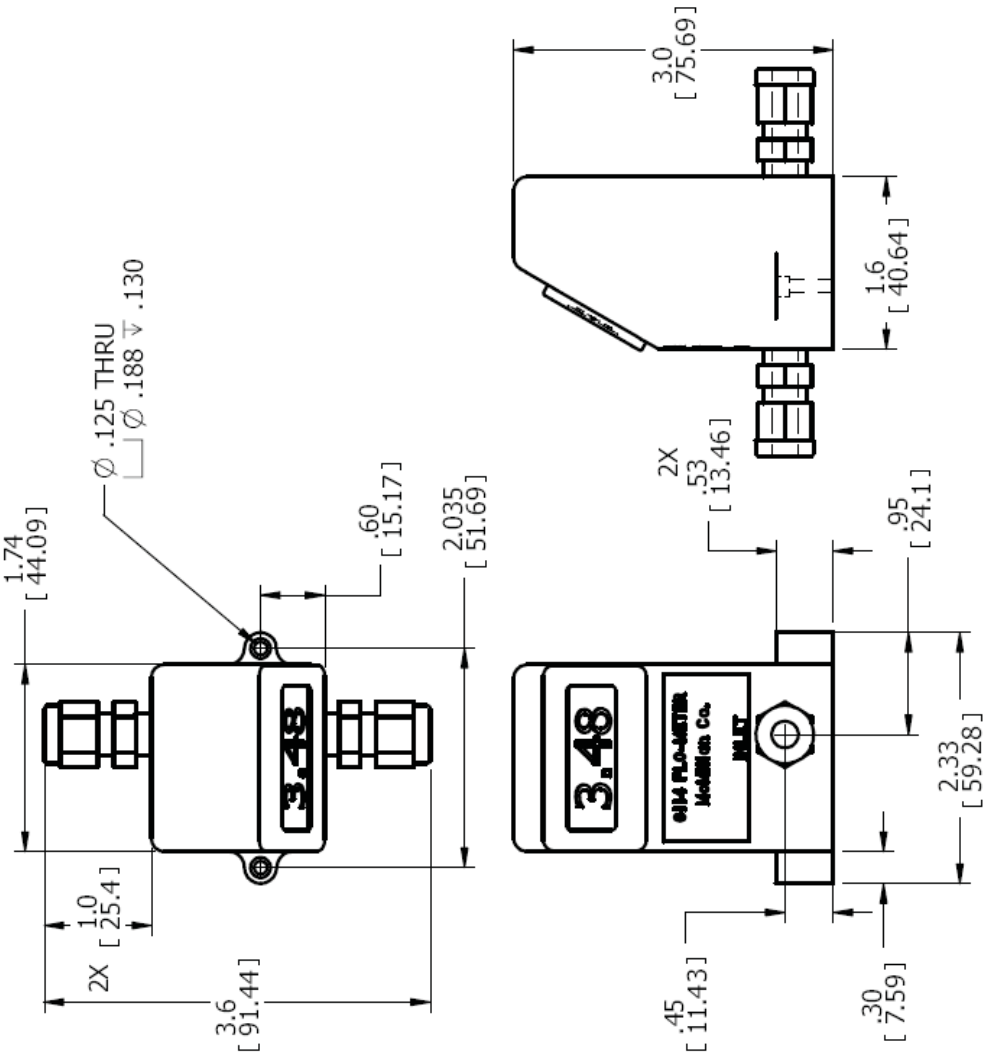
Model 107 - Flow Ranges 3-9,
"S4" Fittings Shown



Model S-111 - Flow Ranges 3-9,
"A4" Fittings Shown

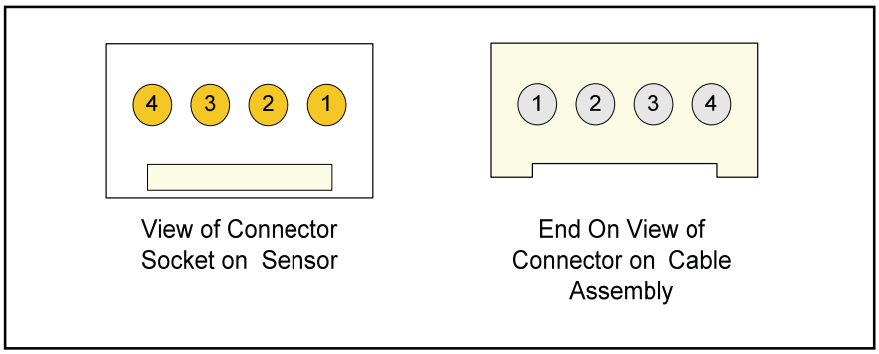


Model S-112 & S-114 - Flow Ranges 3-9,
"B4/S4" Fittings Shown



I. Connector Pin & Wire Color Cross Reference

End On View of Connector Socket and Connector



Standard Accuracy Units:

Pin	Cable Wire Color	Unit Output		
		Voltage	**Voltage & Pulse**	**Current**
1	Black	Signal & Power Negative (Ground)	Signal & Power Negative (Ground)	Signal & Power Negative (Ground)
2	White	Voltage Output	Voltage Output	Current Output
3	Red	Power Positive	Power Positive	Power Positive
4	Green	Not Used	Pulse Output	Not Used

Improved Accuracy (H Suffix) Units:

Pin	Cable Wire Color	Unit Output		
		Voltage	**Voltage & Pulse**	**Current**
1	Black	Power Negative (Ground)	Signal & Power Negative (Ground)	Power Negative (Ground)
2	White	Voltage Output	Voltage Output	Current Output
3	Red	Power Positive	Power Positive	Power Positive
4	Green	Signal Negative (Ground)	Pulse Output	Signal Negative (Ground)

J. Limited Warranty For Gas and Liquid Micro-Turbine Flow Products and Associated Standard Accessories (Excludes Ultra High Purity Products)

DURATION OF LIMITED WARRANTY, MATERIALS & WORKMANSHIP

R.D. McMillan Co., Inc., hereinafter referred to as "McMillan", warrants these products and their associated standard accessories manufactured by McMillan and supplied hereunder, to be free from defects in materials and workmanship for a period of twelve (12) months from the date of shipment to the customer when installed, serviced and operated in its recommended environment. This warranty is not affected in any part by McMillan providing technical support or advice.

Replacement parts are warranted to be free from defects in material or workmanship for ninety (90) days or for the remainder of the Limited Warranty period of the McMillan product in which they are installed, whichever is longer. Parts not installed by factory authorized service centers may void the warranty.

PRODUCT RETURNS

(a) General Policy:
Any product or parts determined by McMillan's inspection to have failed per this warranty, will at McMillan's option, be repaired or replaced with an equivalent or comparable product without charge. McMillan's obligation hereunder shall be limited to such repair and/or replacement and shall be conditional upon McMillan's receiving written notice of any alleged defect within ten (10) days of its discovery. The customer will, however, be responsible for returning the product to McMillan's manufacturing facility in Georgetown, Texas, U.S.A., and for assuming the cost of removing the original product and reinstalling the repaired or replaced product. A written specific explanation of the problem must be included with each returned product. Returned goods should be properly packaged to prevent shipping damage and shipped prepaid to McMillan.

(b) Safety Requirements:
For safety reasons, McMillan must be advised of any hazardous fluid or toxic materials that were in or on the product to be returned. Customer must certify in writing that all such hazardous, corrosive or toxic substances have been completely removed, cleaned or neutralized from the returned product prior to shipment to McMillan. McMillan shall hold the returned items pending receipt of customer's statement for defect and certification of cleanliness of returned items, provided that, prior to such receipt, risk of loss of returned items shall remain with customer. Flow sensors, flow meters and flow controllers must be thoroughly cleaned to remove any toxic, corrosive or hazardous fluids that may internally remain therein before shipping product to McMillan.

(c) Shipping Requirements:

Customer is responsible for all shipping charges (except for those products under warranty, in which cases customer shall bear the cost of inbound shipping as described herein below, and McMillan shall bear the cost of outbound shipping). Customer is responsible for the costs of out of warranty repairs and/or recalibration. McMillan will ship items repaired under warranty back to customer by the most economical shipping means. Expedited shipping methods may be available at customer's expense. All returned items shall be returned to a McMillan authorized service center., freight prepaid, accompanied or preceded by a particularized statement of the claimed defect and with a clearly readable Returned Material Authorization ("RMA") number affixed to the shipping label. Contact McMillan Customer Service Department for RMA number. Warranty claims shall be made only by using the McMillan's Returned Material Authorization form, completely filled out and returned to McMillan in accord with McMillan's Product Return Policy and Procedure Form.

Contact McMillan's Customer Service Department as follows for instructions:

Telephone calls in U.S.A. (CST) 1-800-861-0231
Outside U.S.A. +1 512-863-0231
Or Fax: + 1-512-863-0671
E-mail: sales@mcmflow.com

DESIGN, PROCESS and MANUFACTURING CHANGES

McMillan may make changes in the design or manufacture of any products sold hereunder without incurring any obligation to incorporate such changes into products manufactured prior to incorporation of such design or manufacturing changes. McMillan reserves the right to make design or manufacturing changes without prior notice. McMillan products and replacement parts are manufactured using new materials or new and equivalent to new in appearance, performance and reliability. Due to continuous research, testing, product improvements and enhancements, McMillan reserves the right to change product specifications without notice, except to the extent an outstanding bid obligation exists.

LIMITATION of LIABILITY

Except as expressly set forth in this limited warranty, McMillan makes no other warranties or conditions, express or implied, including any implied warranties of merchantability and fitness for a particular purpose. McMillan expressly disclaims all warranties and conditions not stated in this limited warranty. Any implied warranties that may be imposed by law are limited in duration to the limited warranty period. Buyer/customer agrees that models or samples shown to buyer/customer were merely used to illustrate the purchased product and not to represent, promise or guarantee that any purchased products delivered hereunder would conform to such models or samples. McMillan's distributors or sales representatives have no authority to give warranties beyond those provided in this limited warranty.

If customer's product fails to work as warranted herein, customer's sole and exclusive remedy shall be the repair or replacement at McMillan's option. McMillan is not liable for any damages caused by the product or the failure of the product to perform, including any lost profits or savings, incidental or consequential damages. McMillan is not liable for any claim made by a third party or made by a buyer for a third party. No actions arising out of sale of the products sold hereunder or this limited warranty may be brought by either party more than two (2) years after the cause of action accrues. This limitation of liability applies whether damages are sought, or a claim made, under this limited warranty or as a tort claim (including negligence and strict product liability), a contract claim, or any other claim. This limitation of liability cannot be waived or amended by any person. This limitation of liability will be effective even if customer has advised McMillan or an authorized representative or distributor of McMillan of the possibility of any such damages

This limited warranty gives customer specific legal rights. Customer may also have other rights that may vary from state to state or country to country. Customer is hereby advised to consult applicable state or country laws for a full determination of customer's rights.

EXCLUSIONS FROM WARRANTY

This limited warranty provided herein shall not apply to any product which:

(1) has been repaired or altered outside of McMillan's factory (or authorized service center) in any way so as, in McMillan's judgment, to affect such purchased item's reliability or performance.
(2) has been subject to misuse, mishandling, negligence, accident, or acts of God.
(3) has been operated other than in accordance with the printed instructions prepared by McMillan and provided by McMillan with the product.
(4) has been returned to McMillan after more than thirty (30) days following the date of the alleged product failure.
(5) has been returned to McMillan without complying with the Safety Requirements or the Shipping Requirements contained herein.
(6) requires calibration and/or routine maintenance, unless this calibration or routine maintenance is required as a result of a product failure that is covered under terms of this warranty.
(7) are consumable parts, such as filter elements, batteries or tube fittings.
(8) requires replacement or repairs resulting from buyer's improper choice of product flow range, or require repair or replacement due to buyer subjecting product to corrosive fluids or other fluids not suited for use in product
(9) has flow passages clogged due to failure to use a filter to protect product from particulates in fluid flow stream, or other cause to produce clogged passages
(10) has been operated outside of recommended specifications (such as voltage, temperature, or flow range, etc.)
(11) has been damaged or cracked due to negligence in failing to follow printed instructions to prevent excessive torque from being applied to product housing (generally polyphenylene sulfide plastic)
(12) has been damaged as a result of gross over-speeding, or prolonged over-speeding of the micro-turbine wheel

(13) has been damaged as a result of severe sudden impact forces (example: dropping the product)

METHOD OF SETTLEMENT OF ANY CLAIMS, DISPUTES AND CONTROVERSIES

The provisions of this warranty are severable and if one or more provisions are deemed invalid, the remaining provisions shall remain in effect. Further, in the event that any provision is held to be over broad as written, such provision shall be deemed amended to narrow its application to the extent necessary to make the provision enforceable according to applicable law and shall be enforced as amended. This warranty shall be construed and interpreted in English.

All claims, disputes and controversies arising out of or relating in any way to claims under any warranties, either express or implied (including implied warranty of merchantability), or claims based on any consumer protection act or deceptive trade practice act, contract, tort, statute, or common law, or any alleged breach, default, and/or misrepresentation, will be resolved by means of final and binding arbitration. This limited warranty, including any contests to the validity or enforceability of this limited warranty, shall be finally settled by arbitration under the Rules of Conciliation and Arbitration of the International Chamber of Commerce by one or more of its arbitrators appointed in accordance with the Rules, and judgment upon award rendered may be entered in any court having jurisdiction thereof. The place of arbitration shall be Austin, Texas U.S.A., and the Texas Uniform Commercial Code, as then enacted shall govern the rights and duties of the parties of this agreement without regard to conflicts-of-law principles. The arbitration shall be conducted in English. The UN Convention on Contracts for the International Sale of Goods shall not apply to this Limited Warranty.

R. D. McMillan Company, Inc.
7075 R.R. 2338
P. O. Box 1340
Georgetown, Texas U.S.A. 78627

K. Troubleshooting Guide

Symptom	Possible Cause	Method of Correction
Unit Leaks.	Fittings not tight enough.	Tighten fittings (see section B4).
	Sensor assembly cracked.	Unit must be returned for repair (see Section J).
No output signal or flow indication.	No power or low power.	Apply correct power.
	No flow passing through unit.	Display or output should read zero if there is no flow. Increase the flow rate until a reading is obtained. (Do not exceed the specified maximum flow!).
	Output shorted or overloaded.	Check electrical connections (see section B5).
	Improper connection.	Check electrical connections (see section B5) and ensure connector is correctly plugged in.
	Moisture on internal electronics.	Allow unit to dry out in a dry environment.
	Output circuitry damaged.	Unit must be returned for repair (see Section J).
	Liquid not translucent enough.	Contact the McMillan Service Department for assistance.
	Attempting to measure flows below the specified minimum for the unit.	Use higher flow rates.
Flow reading accuracy is outside the specification.	Liquid has a different viscosity and / or specific gravity than water at 20°C.	Calculate the flow reading error / offset as explained in section C6.
	Entrapped air or gas.	Remove the entrapped air (see section C2).
	Mechanical sensor assembly damaged.	Unit must be returned for repair (see Section J).

Symptom	Possible Cause	Method of Correction
Flow indication is not linear and output too low at lower flows	Attempting to measure flows below the specified minimum for the unit	Use higher flow rates.
	Liquid is too viscous	Best results are obtained with liquids that have a viscosity of 10cS or less. Contact the McMillan Service Department for further information.
	Entrapped air or gas	Remove entrapped air (see section C2).
	Mechanical sensor assembly damaged	Unit must be returned for repair (see Section J).
Flow indication "bounces" or fluctuates	Flow is actually fluctuating	Correct flow source to obtain steady flow.
	Not using the fittings supplied by the manuafacturer	Use the supplied fittings.
	Entrapped air or gas	Remove entrapped air (see section C2).
	Turbulence in tubing or sensor	Straighten the inlet tubing or lengthen it to at least 6" (150mm).
	Fluctuating input power	Correct the power source or change to a regulated supply.
	Mechanical sensor assembly damaged	Unit must be returned for repair (see Section J).
Flow indication is fixed at one value	The maximum rated flow for the unit is being exceeded.	Reduce the flow.
	Output circuits may be damaged	Unit must be returned for repair (see Section J).

L. Contacting McMillan

Website: www.mcmflow.com
Email: tech@mcmflow.com

Mailing address: McMillan Company
P.O. Box 1340
Georgetown, TX 78627
U.S.A.

Shipping address: McMillan Company
7075 RR 2338
Georgetown, TX 78633
U.S.A.

Phone: (512) 863-0231
Fax: (512) 863-0671

For repairs and/or return information, please contact our service department any of the ways shown above.